REMARKS

Applicants appreciate the detailed examination evidenced by the Official Action mailed June 24, 2004 (hereinafter the Official Action). In response, Applicants have extensively amended independent Claims 1, 8, 14, 21 and 31 to further distinguish the patentable subject matter recited therein from the cited references and to expedite examination and allowance of the present application. Applicants also have canceled Claims 4 and 5. Applicants, therefore respectfully request entry of the present amendment and allowance of all claims in due course.

Independent Claim 31 Has been amended to Include Recitations Similar to Those of the Other Independent Claims

Independent Claim 31 stands rejected under 35 USC § 102(e) over U.S. Patent No. 6,566,205 to Yu (hereinafter Yu). *Official Action, page 2.* In response, Applicants have extensively amended Claim 31 along the lines of those amendments made to the remaining independent claims, as discussed herein below in further detail. Accordingly, Applicants respectfully submit that the rejection of Claim 31 under § 102 over Yu is now moot and should be withdrawn.

Claims 1-3 and 6-31 are Patentable over the Cited References

Claims 1-31 stand rejected under 35 USC § 103 over a combination of U.S. Patent No, 6,451,641 to Halliyal (hereinafter Halliyal) and U.S. Patent Application Publication No. 2002/0153579 to Yamamoto (hereinafter Yamamoto), in view of Yu and U.S. Patent No, 6,251,761 to Rodder (hereinafter Rodder), and U.S. Patent Application Publication No. 2003/0234417 to Raaijmakers (hereinafter Raaijmakers). *Official Action, page 3.* Applicants respectfully submit that the amended independent claims are patentable as even if the cited references were combined, the combination would not disclose or suggest all of the recitations of the claims, and further there is no clear and particular evidence of a motivation or suggestion to combine the references for at least the reasons discussed herein.

To establish a *prima facie* case of obviousness, the prior art reference (or references when combined) must teach or suggest all the claim limitations. Applicants have amended independent Claim 1 to recite in part:

> nitriding a high dielectric layer on a silicon substrate, wherein said high dielectric layer comprises a multi-layered nano laminate formed by forming a hafnium oxide layer or a zirconium oxide layer on the substrate using atomic layer deposition and then forming a Group 3 metal oxide layer thereon using atomic layer deposition; and
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> post treating the high dielectric layer and silicon substrate.

Independent Claim 1. Independent Claims 8, 14, 21 and 31 include similar recitations. As understood by Applicants, none of the cited references discloses or suggests the specific formation of a multi-layer nano laminate by first forming a hafnium oxide layer or a zirconium oxide layer and then forming a Group 3 metal oxide layer thereon, wherein each of the layers is formed using atomic layer deposition (ALD) as recited in Claim 1. For example, as understood by Applicants, Halliyal discusses the formation of high-K gate dielectric materials as "a composite dielectric material" which are described therein as a co-deposition of component elements to form the composite dielectric material. *See, for example, column 3, lines 33-43 of Halliyal.* Therefore, as understood by Applicants, Halliyal discusses the formation of a composite dielectric material (*i.e.*, a single dielectric layer that includes two materials, not a multi-layered nano laminate by forming a hafnium oxide layer or zirconium oxide layer on the substrate using atomic layer deposition and then forming a Group 3 metal oxide layer thereon using atomic layer deposition."

Moreover, as understood by Applicants, Yamamoto also does not disclose or suggest the above-highlighted recitations of the independent claims. For example, Yamamoto discusses the formation of a dielectric by first forming an aluminum oxide film (i.e., Group 3 metal) followed by the formation of a zirconium oxide layer thereon, not first forming a zirconium oxide layer and then forming the Group 3 metal oxide layer, as recited in the amended independent claims. In other words, as understood by Applicants, Yamamoto discusses forming layers in an order that is opposite to the order recited in Applicants' claims.

Yu also does not disclose or suggest the recitations of the amended independent claims highlighted above. In particular, Yu discusses the formation of a single dielectric layer:

> We now describe several processes for the effective introduction of the nitrogen into these three (and other similar) dielectrics:

> 1st process: Beginning with silicon substrate 11, as seen in FIG. 3, high K dielectric layer 35 is first deposited to a thickness between about 50 and 100 Angstroms. This is followed by the deposition, to a thickness between about 5 and 20 Angstroms, of silicon nitride layer 32 onto high K dielectric layer 35. Next, the structure is subjected to a heat treatment whereby nitrogen ions from layer 32 diffuse into layer 35 where they serve to neutralize excess trapped negative charge. The heating process is performed at a temperature of between about 900 and 1,100° C. for between about 0.5 and 2 minutes in an atmosphere of nitrogen. *Yu, column 2, lines 53-64.*
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> ....
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> 2nd process: Beginning with silicon substrate 11, as seen in FIG. 5, high K dielectric layer 55 is first deposited to a thickness between about 50 and 100 Angstroms. This is followed by nitridation from the gas phase 53 (as opposed the solid phase used for the 1.sup.st process). This results in impregnating the layer of high K dielectric with nitrogen to a concentration between about 5 and 10 atomic percent. Then a layer of gate electrode material 12 is deposited onto the nitrogen-impregnated layer 55, following which layers 12 and 55 are patterned and etched to form a gate structure as before. *Yu, column 3, lines 4-14.*

As shown in the above-cited passages of Yu, the dielectric material formed therein appears to have only a single layer and are not a multi-layered nano laminate formed by forming a hafnium oxide layer or zirconium oxide layer using ALD and then forming a Group 3 metal oxide layer thereon using ALD as recited in the amended independent claims.

Similarly, Rodder discusses the formation of a single dielectric layer 108. In particular, Rodder states that:

> Layer 108 will typically comprise an oxygen-containing high-K dielectric material such as Ta2O5, BaTiO3, TiO2, CeO2, or BST. However, layer 108 may alternatively comprise a high-K material that is formed using a process that allows oxygen from another source to enter the environment. *Rodder, column 2, lines 60-65.*

As demonstrated by the above-cited passage of Rodder, the disclosure therein appears to focus primarily on the formation of the single dielectric layer, not a multi-layer nano laminate formed by forming a hafnium oxide layer or a zirconium oxide layer on the

substrate using ALD and then forming a Group 3 metal oxide layer thereon using ALD.

As understood by Applicants, Raaijmakers also does not disclose the above-cited recitations of the independent claims. Raaijmakers appears to discuss a formation of a multi-layered dielectric wherein the layers therein are the same:

> The high-k dielectric materials employed in the preferred embodiments preferably comprise a metal oxide including at least one element from groups IIA, IIIB, and IVB of the periodic table. The high-k dielectric layer can be a multilayered metal oxide, solid metal oxide solution, ternary compound, doped metal oxide, etc. *Raaijmakers, page3, paragraph 0036, lines 2-6.*

Therefore, as understood by Applicants, Raaijmakers discusses the formation of a multi-layered dielectric wherein each of the layers is the same, not a multi-layered nano laminate formed by forming a hafnium oxide layer or zirconium oxide layer on the substrate using ALD and then forming a Group 3 metal oxide thereon using atomic layer deposition. Accordingly, even if all of the cited references were combined as alleged in the Official Action, the combination would not disclose or suggest all of the recitations of the amended independent claims as required under § 103.

Furthermore, there does not appear to be any clear and particular evidence of a motivation or suggestion to combine the cited references as required under Section 103. In particular, there must be some suggestion or motivation, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, to modify the reference or to combine reference teachings, and there must be a reasonable expectation of success of the combination. The teaching or suggestion to make the claimed combination and the reasonable expectation of success must both be found in the prior art, not in applicant's disclosure. See MPEP § 2143. As stated by the Court of Appeals for the Federal Circuit, to support combining references in a § 103 rejection, evidence of a suggestion, teaching, or motivation to combine must be clear and particular, and this requirement is not met by merely offering broad, conclusory statements about teachings of references. *In re Dembiczak*, 50 USPQ2.d 1614, 1617 (Fed. Cir. 1999).

In particular, there is no clear and particular evidence in the art in general or in the references themselves to combine these specific references with one another as

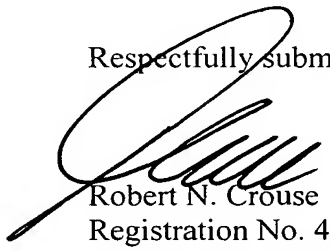
there is no specific teaching (in the case of multi-layer dielectrics) of the order in which layers of the dielectric should or should not be formed. Furthermore, many of the references (such as Yu) do not even discuss multi-layered dielectric structures or formation of multi-layers using ALD for the formation of each of the layers therein (such as Raaijmakers). According, there is no clear and particular evidence of a motivation or suggestion to combine these references as required under § 103.

Amended independent Claims 1, 8, 14, 21 and 31 are patentable over the cited references for at least the reasons discussed above. Furthermore, the pending dependent claims, which depend from the above-cited amended independent claims, are patentable at least per the patentability of the amended independent claims.

CONCLUSION

Applicants have amended the independent claims to further clarify the patentable subject matter recited therein. Furthermore, Applicants have shown that the alleged combination of the cited references does not disclose or suggest all of the recitations of the amended independent claims, and furthermore, that there is no clear and particular evidence of a motivation or suggestion to combine these references as required under § 103. Accordingly, Applicants respectfully request the withdrawal of all rejections and the allowance of all claims in due course. If any informal matters arise, the Examiner is encouraged to contact the undersigned by telephone at (919)854-1400.

Respectfully submitted,



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